

Biodiversity & Conservation

1) Species of ants ^{more than} 20,000

3) Species of fishes - 28,000

2) Species of Beetles - 3,00,000

4) Species of orchids - 20,000 ^{nearly}

* Scientists working \rightarrow **Ecologists**
 \rightarrow **Evolutionary Biologists**

Life originated on earth \approx 3.8 billion yrs ago (bya)

Biodiversity \rightarrow In our Biosphere \rightarrow Immense diversity [or heterogeneity]

All levels of Biol. Organ. also

Species level exist at

Term - **Biodiversity**

to describe

popularised (not coined) by

Socio biologist - **Edward Wilson**

Combined diversity at all the levels of \rightarrow occurs within a species

Biological Organisation

components of biodiversity

Genetic diversity

Species diversity

Ecological diversity

Single species might show high diversity (within species) at Genetic level

Diversity at species level

At \rightarrow ecosystem level

over its **Distributional Range**

Example

India \gg Norway (scandinavian country)

ecosystem diversity

Genetic Variation shown by Rauwolfia Vomifera (medicinal plant)

Western Ghats

have greater

India has \rightarrow Deserts

- Rain forests
- Mangroves
- Coral reefs
- Wetlands
- Estuaries
- Alpine meadows

Himalayan ranges growing in

might be in terms of **Potency** **Concentration**

amphibian species diversity

Eastern Ghats

produced by plants active chemicals (Reserpine)

India has

Takes million of years of evolution to

accumulate Rich diversity in nature

Genetically diff strains of

RICE

Varities of mango

mango

We can Lose all the wealth.

But

< 2 centuries

Present rates of species losses continue

> 50,000 more than

1000

How Many Species are there on Earth & How Many in INDIA

Acc to → International Union for Conservation of Nature & Natural Resources (IUCN), 2004.

Slightly more than 1.5 million

Total no. of ^{plants} animal species

* For many Taxonomic Groups → species inventories more complete in

Tropical countries than Temperate

* Considering → overwhelmingly of species waiting to be discovered are in large proportion

Temperate - tropical species richness of statistical comparison Biologists make a Tropics

of exhaustively studied group of Insects → extrapolate this ratio to other groups

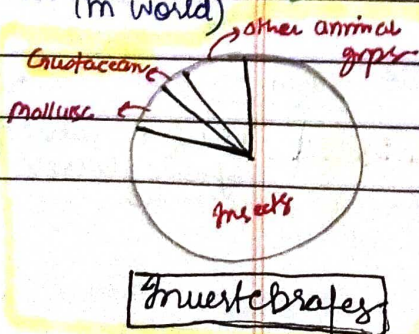
Total no. of species on earth ← Gross estimate of to come up with animal plants
Some extreme estimates range → 20 to 50 million

* Note → Conservative } sound estimate made by Robert May
Scientifically }
7 million ← at Global diversity place

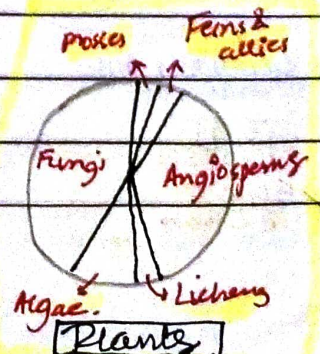
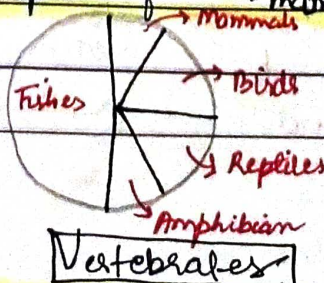
* > 70% of all species are animals not more than
* Plants (algae, fungi, Bryophyte, Gymnosperm, Angiosperm) are 22%

* Among animals, Insects → Most species-rich taxonomic group
→ 70% of Total → 7/10 → insects animals
more than

* No of Fungi species (in world)



(all vertebrates) combined total of species of



These estimates do not give any figures for Prokaryotes

Biologists not sure about how many prok. species might be there.

Conventional Taxonomic Method is Problem

are not suitable for identifying microbial species many species] not culturable

If we accept Biochemical criteria } for delineating species of this grp
Molecular criteria } laboratory conditions

millions might run into their diversity alone

India has 2.4% of world's land area

share in Global species diversity is impressive 8.1%

this makes

Our country

45,000 plant species

2 x 45,000 animal species

1 of 12 mega diversity countries of world.

recorded from India

* If we accept more than May's Global Estimate then only 22% of total species have been recorded so far

> 1,00,000 plant species
more than > 3,00,000 animal species

then there are India applying this in

yet to be discovered & described

* Immense manpower (taxonomists) Time required to complete inventory of Biological wealth of our country

Large fraction of these species faces the threat of becoming extinct even before discovering them this becomes more hopeless

"Nature Biological Library is burning before we catalogued the files of all Books stocked there"

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AIR 1747

Patterns of Biodiversity

(i) Latitudinal Gradients

- Diversity of $\left\{ \begin{array}{l} \text{plants} \\ \text{animals} \end{array} \right\} \rightarrow$ ~~uniform~~ throughout the world. but shows uneven distribution
- many groups of $\left\{ \begin{array}{l} \text{animals} \\ \text{plants} \end{array} \right\} \rightarrow$ there are \rightarrow interesting patterns in diversity most well known

* Species diversity - \downarrow moving from equator to poles. Latitudinal Gradient in Diversity

With very few exceptions, TROPICS - latitudinal range $23.5^\circ \text{N} - 23.5^\circ \text{S}$
 \downarrow harbour more species than \rightarrow temperate areas
 \rightarrow polar areas

Colombia - near equator \rightarrow has nearly 1400 species birds

New York - 41°N \rightarrow has 105 sp. birds

Greenland - 71°N \rightarrow has 56 sp. birds

India - much of its land in tropical latitudes \rightarrow > 1200 sp. birds
more than

* A Forest in tropical region like Equador \rightarrow has 10X as many species of vascular plants

* Largely tropical

Amazonian Rain forest
(In: South America)

Forest of equal area in temperate region as in

Example \rightarrow Midwest of USA

has

Greatest Biodiversity on earth

home to

<u>plants</u> \downarrow maximum <u>> 40,000 sp</u>	<u>Fishes</u> \downarrow 3000 sp	<u>Birds</u> \downarrow 1300 sp	<u>427 sp</u> \downarrow <u>amphibians</u> <u>mammals</u>	<u>Reptiles</u> \downarrow <u>1378</u>	<u>Invertebrate</u> \downarrow more than <u>> 1,25,000</u>
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Scientists estimate \rightarrow in these Rain forest

there might be at least 2 million insect species

waiting to be discovered and named.

Why tropics - Greater diversity?

Ecologists & Evolutionary Biologists proposed various hypotheses → some important

Speciation

is generally function of time

unlike temp. regions subjected to frequent glaciation in past.

Tropical latitudes have remained relatively undisturbed for million of years.

thus had long evolutionary time for species diversification

Tropical environments unlike temperate ones

less seasonal
relatively more constant & predictable

Such constant environments

promote niche specialisation

lead to ↑↑ species diversity

Tropics have

↑↑ solar energy available

contributes to

Higher productivity

this in turn might contribute to indirectly

Greater diversity

ii) Species - Area Relationship

Great German Naturalist Geographer

ALEXANDER VON HUMBOLDT

Wilderness of South American jungles

in during his pioneering & extensive exploration

observed that within a region species richness increased with increasing explored area

Relation b/w species richness & area (but only upto a limit)

Wide variety of Taxa

angiosp. plants

Birds

Bats

Fresh water fish

turns to be Rectangular hyperbola

$$S = CA^Z$$

* On Logarithmic scale, relationship is a straight line

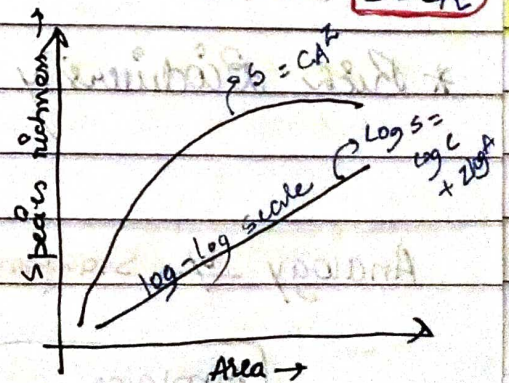
$$\log S = \log C + Z \log A$$

S = species richness

A = area

Z = slope of line (regression co-efficient)

C = y-intercept



Ecologists have discovered \rightarrow value of z $\xrightarrow{\text{lies in}}$ $0.1 \text{ to } 0.2$ $\xrightarrow{\text{regardless of}}$ Taxonomic group

slope of regression line $\left[\begin{array}{l} \bullet \text{ plants in Britain} \\ \bullet \text{ Birds in California} \\ \bullet \text{ Mammals in New York} \end{array} \right] \xrightarrow{\text{whether its a}} \left[\text{Region} \right]$

\rightarrow amazingly similar

* If you analyze \rightarrow species area relationships $\xrightarrow{\text{among}}$ very large areas (like continents)

$\xrightarrow{\text{much steeper}}$ $\xrightarrow{\text{to be}}$ slope of the line $\xleftarrow{\text{you will find}}$

\rightarrow z values $\xrightarrow{\text{in range of}}$ 0.6 to 1.2

* Example \rightarrow Frugivores (fruit eating) birds $\xrightarrow{\text{in}}$ Tropical forests $\xrightarrow{\text{of}}$ different continents

1.25 $\xleftarrow{\text{slope is found}}$

* The Importance Of Species Diversity to the Ecosystem

* For many decades \rightarrow Ecologists believed \rightarrow Communities with more species $\xrightarrow{\text{than}}$ those with less species $\xrightarrow{\text{tend to be}}$ more stable $\xleftarrow{\text{generally}}$

A stable community \rightarrow (1) Too much ~~variability~~ in productivity year to year.

(2) Resistant / Resilient to occasional disturbance $\xrightarrow{\text{natural}}$ $\xrightarrow{\text{man made}}$

~~(3) Resistant to invasion by~~ \rightarrow alien species

David Tilman's Long term Ecosystem Experiments

$\xrightarrow{\text{using}}$ outdoor plots

\downarrow found that

plots with more species $\xrightarrow{\text{showed}}$ less year to year variation $\xrightarrow{\text{in}}$ total biomass

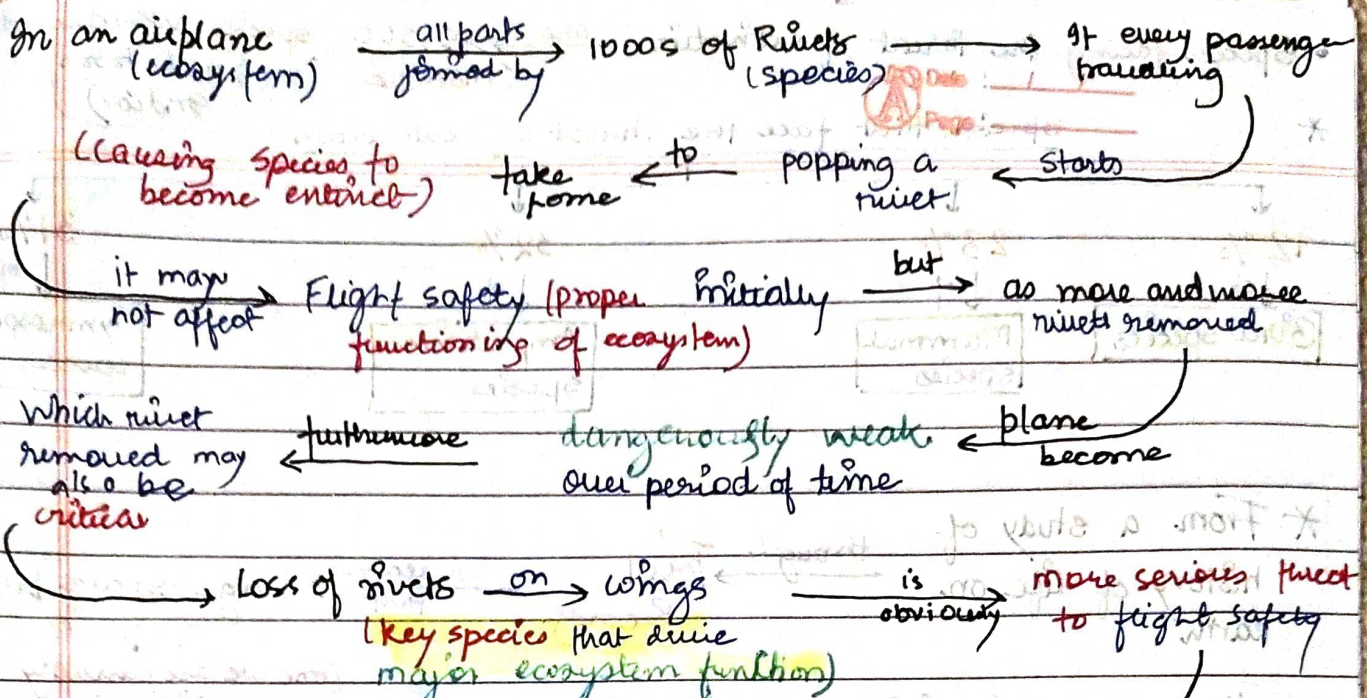
also showed \rightarrow $\uparrow\uparrow$ diversity contributed to higher productivity

* Rich Biodiversity $\xrightarrow{\text{essential for}}$ Ecosystem health $\xrightarrow{\text{imperative for}}$ Survival of human race on this planet.

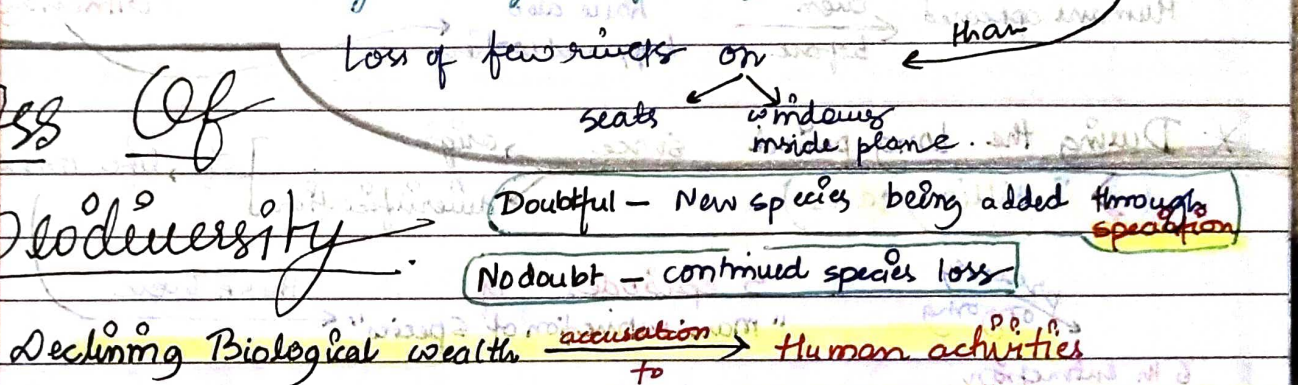
Analogy $\xrightarrow{\text{by}}$ Stanford Ecologist Paul Ehrlich \rightarrow RIVET POPPER HYPOTHESIS

Airplane - ecosystem

Rivets - species

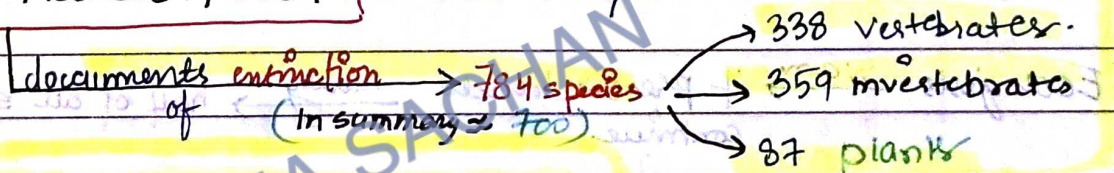


Loss Of Biodiversity

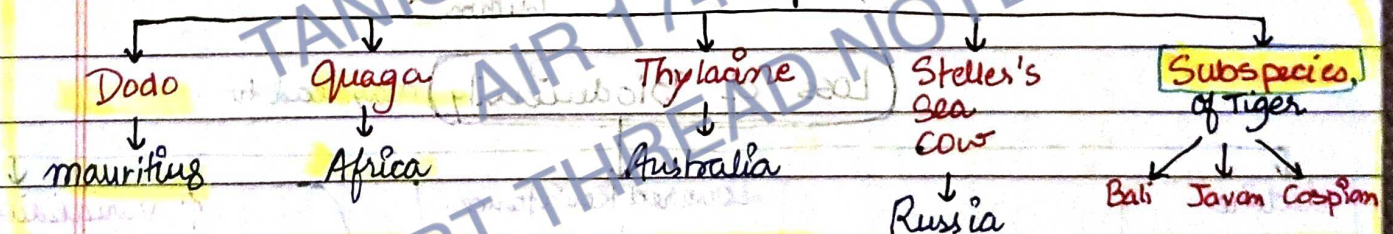


* Colonisation of Tropical Pacific Islands by humans $\xrightarrow{\text{more than led to}}$ Extinction of 2000 species of Native Birds

* IUCN Red List, 2004 in last 500 yrs



* Some RECENT EXTINCTIONS include



* Last 20 yrs alone witnessed disappearance of 27 species

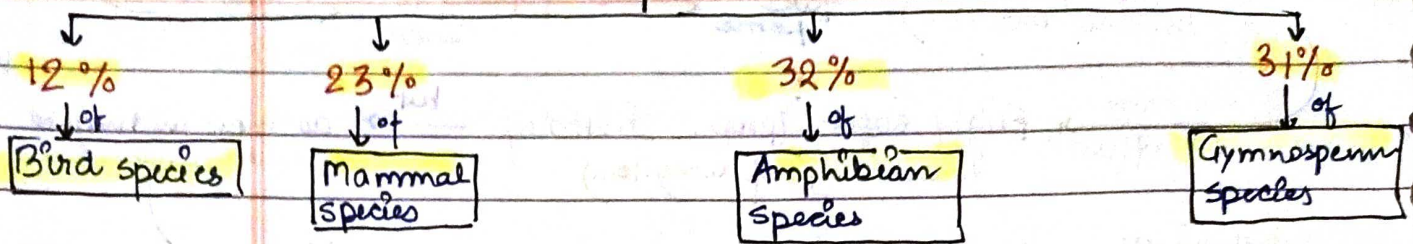
* Careful analysis of records show extinction across taxa random

some amphibian grps more vulnerable to extinctions

- Species facing the threat of extinction are \rightarrow 15,500 species worldwide
 \rightarrow more than \rightarrow (> 650 from India)

*

Species that face the threat of extinction



* From a study of history of life on earth through Fossil Records we learn that Large-scale loss of species (one we are currently witnessing) have also happened earlier. Humans appeared even before.

* During the long period since origin of life on earth (> 3 billion years) diversification

presently ongoing

5 episodes of "mass extinction of species" there were

6th extinction

difference in this is Rates - 100 to 1000 times faster than Pre human times

responsible for faster rates

our activities

8

Ecologists warn if present trends continue nearly half of all species on earth

100 yrs next wiped out within might be

Loss of Biodiversity may lead to

decline in plant production

Lowered Resistance to Environmental perturbation (like Drought)

↑ variability in certain ecosystem processes as

Plant productivity

Water use

Pest & Disease cycles

Cause Of Biodiversity Losses → accelerated species loss / extinction due to human activities.

The Evil Quartet

Co-extinction

When species extincts
 ↓
 plant & species associated animal
 obligatory way with it
 → also become extinct
 it's unique assemblage of parasite also extincts.
 Another example
 ↓
 Coevolved plant pollinator mutualism
 → where
 extinction of one
 → invariably leads to
 extinction of other

Alien species invasion

Alien species introduced (unintentionally or deliberately)
 for any purpose.
 (some of them) → turns invasive
 → decline → cause
 of extinction
 * Nile perch
 Lake victoria introduced in (East Africa)
 → eventually → extinction of ecologically unique assemblage
 > 200 species of cichlid fish in lake.
 Threat of native species by invasive weed species like
 Lantana
 Water hyacinth (Eichhornia)
 Calat grass (Pennisetum)
 Illegal introduction of African Catfish
 → purpose to
 → aquaculture
 Threat to indigenous catfishes in our rivers.

Over-exploitation

Humans depends on natural food shelter for
 when 'need' → hunt → greed
 → leads to
 over exploitation
 ↓ of natural resources
 many species extinctions
 Last 500 yrs
 ↓ in
 Passenger Pigeon
 ↓ in
 Steller's sea cow
 were due to overexploitation by humans
 PRESENTLY → Many marine fishes population
 ↓
 around world
 harvested
 → endangering
 continued existence of some commercially important species

Habitat Loss & Fragmentation

Most imp cause for extinction of animals
 • Most dramatic example comes from Tropical Rain Forests
 Once covered 14% of earth's land surface more than
 Now cover < 6%
 being destroyed fast
 By the time you finish reading this chap, 1000 more hectares of Rain forest would be lost
 * Amazonia Rain 30% huge
 → being
 → cut & cleared
 → cultivating soyabean
 → Conversion to Grassland (to raise beef / cattle)
 Besides total loss, degradation of many habitat by pollution
 Threats → survival of many species
 Large habitats broken into small fragments
 various human activities due to
 affects
 Mammals, Birds acquiring large territories
 Certain crim etc with migratory habitat

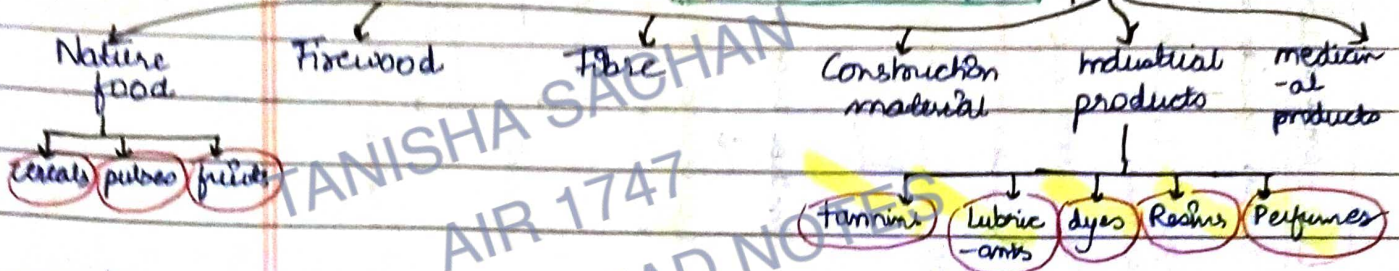
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Biodiversity Conservation

Why should we conserve Biodiversity? 3 reasons, some obvious, some not, but all important.

(i) (NARROWLY UTILITARIAN) → obvious arguments

- Humans derive countless direct economic benefits from



- > 25% of drugs currently sold in market worldwide derived from plants

Traditional medicines contribute to 25000 species of plants

used by → Native peoples around the world

Nobody knows → how many more medicinal plant there are in Tropical Rain Forest

* Increasing resource put into → BIOPROSPECTING (Waiting to be explored)

exploring → molecular scientific species → biodiversity for products of economic importance (not ecological)

* Nations endowed with rich biodiversity can expect to reap enormous benefits

(ii) (BROADLY UTILITARIAN) argument says: biodiversity plays major role in many ecosystem services that nature provides

* Amazon Rain forest expected to produce 20% of Total oxygen in atmosphere through photosynthesis

* Pollination provided by ecosystem through Pollination layer. Bees, Bumblebees, Birds, Bats

* Aesthetic pleasures of Walking through woods, Spring flowers watching, Wake up to Bulbuls song

(iii) (ETHICAL) arguments concerning Biodiversity relate to what we owe to millions of

Philosophically Spiritually → we need to realise every species have intrinsic value. Plant, animal, microbes → with them we share our planet. even if it not be of economic value → Moral duty to pass bio-legacy to next gen.

How do we conserve Biodiversity?

In-situ

We → conserve
→ protect → whole ecosystem
Biodiversity → its
at all levels
is protected

We save entire forest
tigers → to save

On site conservation

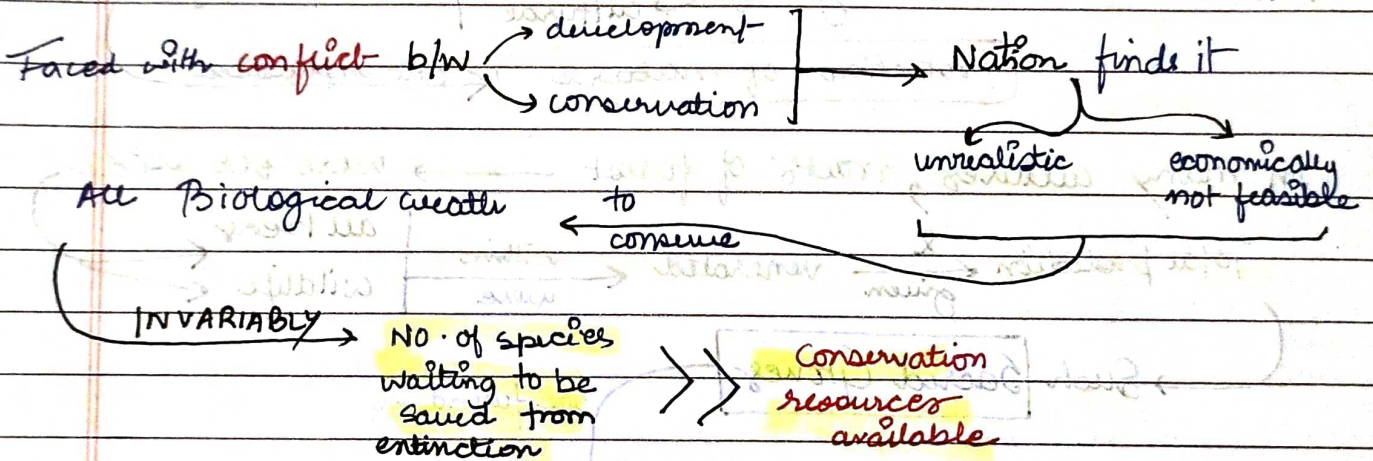
Ex-situ

IF → animal
→ plant → endangered
threatened
organism facing very high
risk of extinction in world.
in near future.

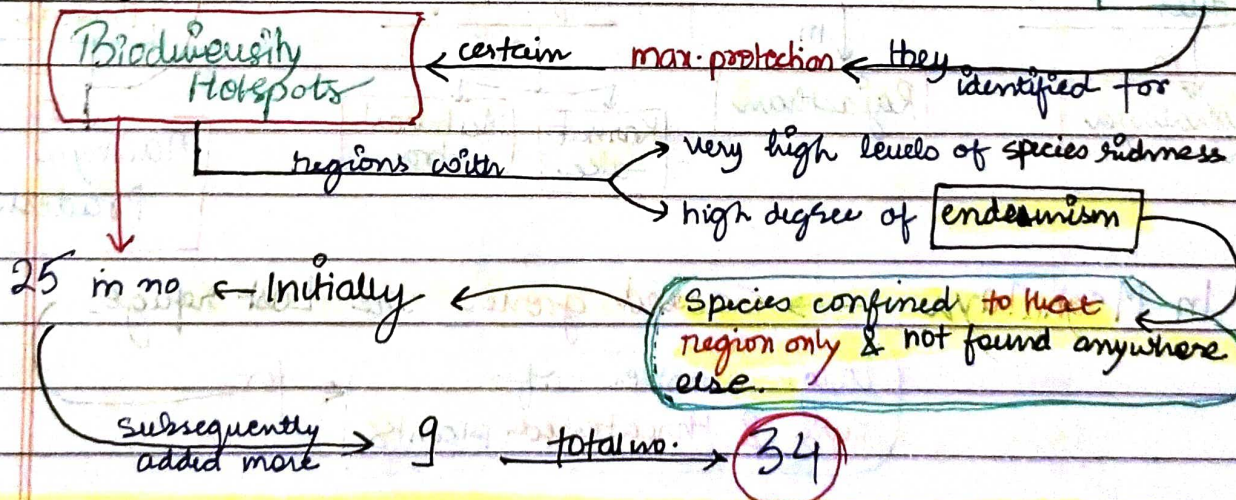
needs
urgent measures to save it
from extinction.

Off site conservation

In-Situ Conservation



* On global basis → this problem has been addressed by → eminent conservationist



* These Hotspots → regions of accelerated habitat loss.

3 of these hotspots cover India's exceptionally high Biodiversity regions

→ Western ghats - Sri Lanka
→ Indo-Burma
→ Himalayas.

All Biodiversity hotspots put together cover.

cover

< 2% of earth's land area.
less than

* These hotspots → no of species collectively is extremely high

30%

by

Ongoing mass extinction

could reduce

strict protection of these hotspots

In INDIA, ecologically unique & biodiversity-rich regions

Biosphere reserves

National parks

Sanctuaries

legally protected

are

* INDIA

has

Biosphere reserves — 14

National parks — 90

Wildlife sanctuaries — 448 (in summary — >450)

India

has

History of

religious & cultural

traditions

Protection of nature

that emphasised

In many cultures, tracts of forest

were set aside

Total protection

& given

venerated

within were

all trees

wildlife

Such Sacred Groves

are found in

Khasi & Jaintia Hills

Aravalli Hills

Western Ghats regions of

Sarguja

Chandaul

Bastar

Meghalaya

Rajasthan

Karnataka

Maharashtra

Madhya Pradesh

* In Meghalaya

→ Sacred groves are last refuges

large number of rare & threatened plants

for

Ex-Situ Conservation

In this approach, threatened plants & animals

special setting

placed in

taken out from their natural habitat

are

where they can be → protected & given special care.

Zoological parks

Botanical Garden

Wildlife Safari Parks

* There are many animals that have become extinct in wild

Zoological parks ← but continue to be maintained in

* In recent years, Ex-situ conservation

Keeping threatened species in enclosures. ← has advanced beyond

Now gametes of threatened species
long periods for viable fertile cond. → can be preserved
using cryopreservation techniques

* Eggs can be fertilised in vitro

* Planks can be propagated using Tissue culture methods

* Seeds of different Genetic Strains of commercially important plants

Long periods in Seed Banks ← can be kept for

Biodiversity $\xrightarrow{\text{knows}}$ No ~~political~~ ~~Boundaries~~

$\xrightarrow{\text{its conservation}}$ collective responsibility of all nations

* Historic Convention $\xrightarrow{\text{on}}$ Biological Diversity

$\xrightarrow{\text{held in}}$ "The Earth Summit"

Rio de Janeiro
(in 1992)

called upon all nations to take

appropriate measures

Biodiversity \leftarrow of

Sustainable Development

of its \rightarrow benefits

* World Summit on Sustainable Development

\downarrow in

2002 Johannesburg South Africa

190 countries

pledged their commitment to achieve by 2010

a significant reductions

\downarrow in

current rate of Biodiversity of Loss

of

Global

Regional

Local

* Calculate approximate no. of insect species in unit area having 98545 total Species Diversity

70% of \uparrow
are animals = 5981

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4187 = 70% of
are insects \uparrow